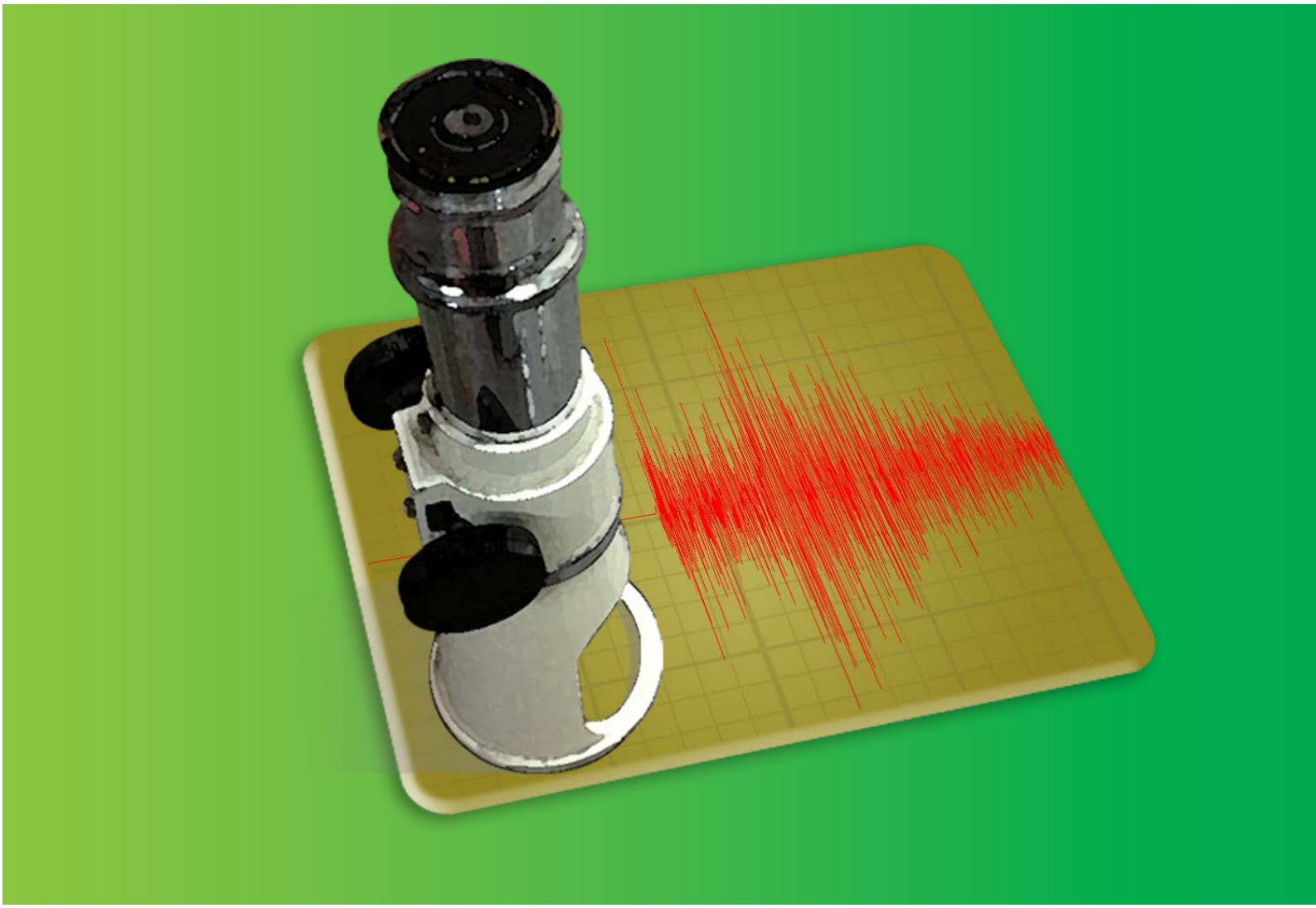
# eqWave 3

SEISMIC WAVEFORM ANALYSIS

environmental systems & services

# PRODUCT USER MANUAL



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# History

## The Kelunji Seismic Recorder

The Seismology Research Centre (SRC) was established in 1976 and incorporated into Environmental Systems & Services (ES&S) in 2002. In the 1980s the SRC began developing digital seismic recorders: the **A**lpha, the **B**eta, the Kelunji **C**lassic, the Kelunji **D**-series, the Kelunji **E**cho, and the current 6th generation instruments: the Kelunji EchoPro/**F**usion twins.

*Above: the Kelunji EchoPro range of seismic recorders*

## The SUDS data format

When the Kelunji D-series was introduced in the mid 1990s the SRC decided to adopt a global standard data format for our seismic recorders. The SUDS (Seismic Unified Data System) was originally created at the U.S. Geological Survey and adopted for use in the IASPEI Seismological Software Library, where it became known as PC-SUDS. It is a very flexible format which contains many fields for information relating to the raw data, which has enabled our eqWave software to provide very useful information to Kelunji users.

For more information on SUDS, visit www.banfill.net/suds.html

# Installing eqWave

## *Java Runtime Environment*

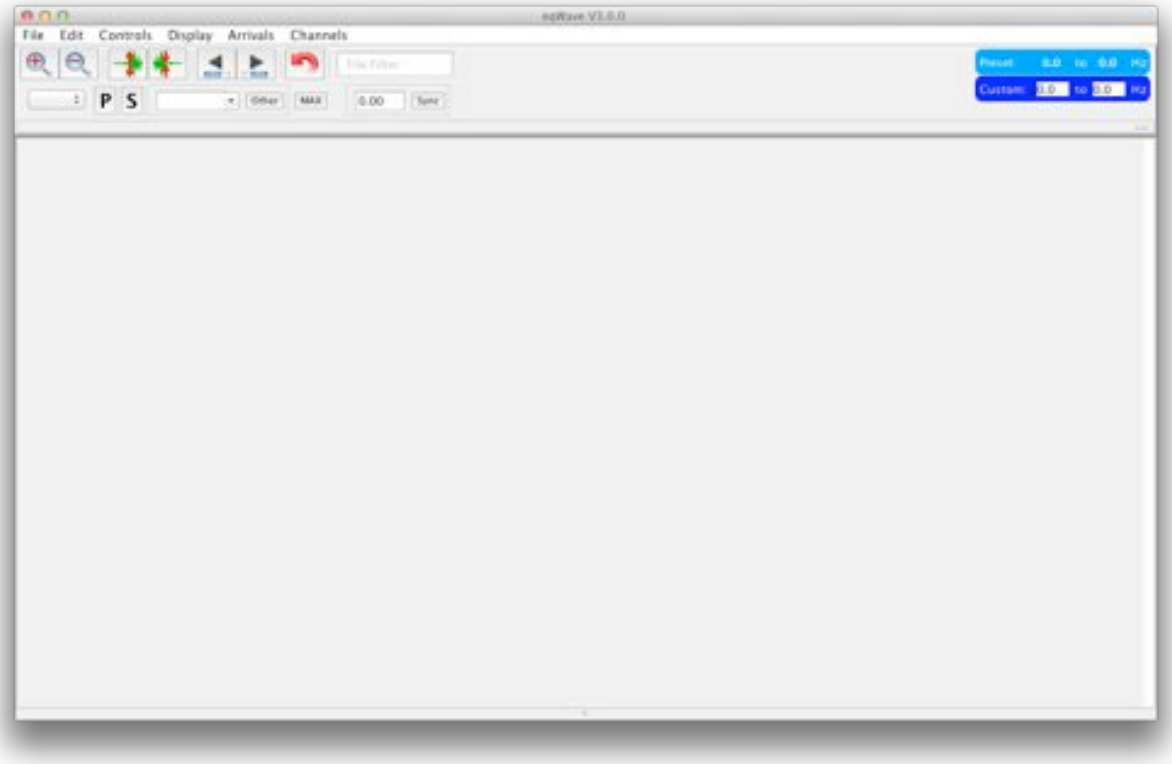
eqWave is a Java application, which means that the Java Runtime Environment needs to be running on your Windows, Mac or Linux computer. You can install Java for free by web browsing to www.java.com and following the download prompts.

## *Application Installer*

The installation procedure differs for each computing platform. The Windows version is supplied as a self-installing package, the Mac version is a zipped OS X application file, and the Linux version is simply the Java Archive (.jar) file.

## *eqWave Window*

When eqWave starts up, you will be presented with the window below, which shows the basic waveform controls at top left and the filter controls at top right. The main area is where the waveforms will appear, and below this is a pull-up drawer that reveals the frequency spectrum display window. Previous versions of eqWave had a pull-out drawer on the right of the screen to show Arrival times. This has moved to the new Arrivals menu.



# What's New in eqWave 3

eqWave 3 has changed significantly since version 2, although its basics remain familiar and easy to use. The main changes include:

- Displaying colour-coded waveforms according to their units
- The ability to convert between ground motion units at the click of a button
- Display Rotational sensor units
- A new implementation of the signal filtering interface
- New keyboard shortcuts
- Moving the Arrivals pull-out window to a menu item
- Simplified user interface with new icons
- Simplification of the frequency display window
- Text table output in zero-offset corrected ground motion units
- Prompts user to save before closing if Arrivals or Channel Properties modified

# What's New in eqWave 3.2

In this update we have added some features and fixed some bugs, including:

- Interaction with eqFocus - displays expected arrival times when location updated
- Timeline always visible
- Click selection to zoom
- Merge contents of a folder, up to 24-hours of data
- Reads gains Kelunji EchoPro files correctly
- Reads KA1 & KA2 (Kelunji Classic) format files correctly
- Fixed displacement, velocity & acceleration unit conversion amplitudes

The vector sum feature and the ability to save in miniSEED format was removed from eqWave 3. These may return in a future update once technical issues have been resolved.

For further information on this and other software products, email seismology@esands.com

# File Handling

## Opening and Closing Files

You can drag a PC-SUDS file from your desktop file browser onto the eqWave window and the file will open. eqWave will open files from a Kelunji that are stored normally (.dmx file extension) or in Gzip compressed format (.dmx.gz file extension). There is no need to expand the Gzip file using a 3rd-party application before using it in eqWave.

Alternatively you can use the **File->Open** menu item (CTRL-O) to browse your computer file system for your file. To close the file and go back to an empty eqWave window use the system window close button, **File->Close** menu item, or CTRL-W.

When you have a file open, you can open another file by dragging it onto the eqWave window or using the Open command again, but this will open the file in a new eqWave window. If you don't want to open a new eqWave window, use the **File->Close & Open** menu item (CTRL-E) instead of the Open command.

## Browsing Files

Once you have opened a file, you can quickly scan through other waveform files in the same directory using the **File->Next** (CTRL-N) and **File->Back** (CTRL-B) menu commands. These waveforms will open in the same eqWave window, replacing the previous file.

### *File Filter*

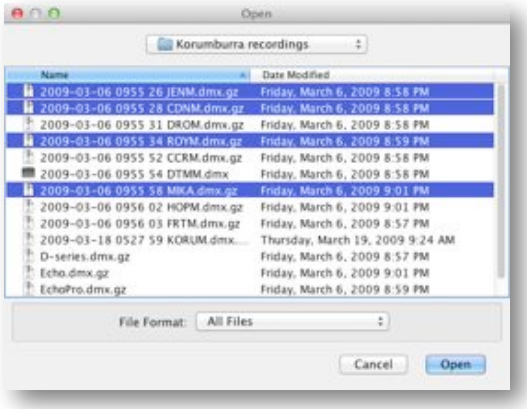
The **File Filter** field in the Basic Controls area is linked to the file browsing tool. If any characters have been typed into this field, when you use the **Next** or **Back** commands, only files that contain those characters in the filename will be opened. For example, if you have a folder full of triggered data from dozens of different stations but you are only interested in viewing files that have the site code ECHOP in the name, by typing ECHOP in the **File Filter** field and using the **NEXT** command, the next file that has ECHOP in the filename will open.

As files created by Kelunji recorders are named in a standard format that includes the date, time and station code (e.g. YYYY-MM-DD_HHMM_SS_<code>.dmx in the EchoPro) you could potentially filter your file browsing by a certain month, day or hour.

# Merging Files

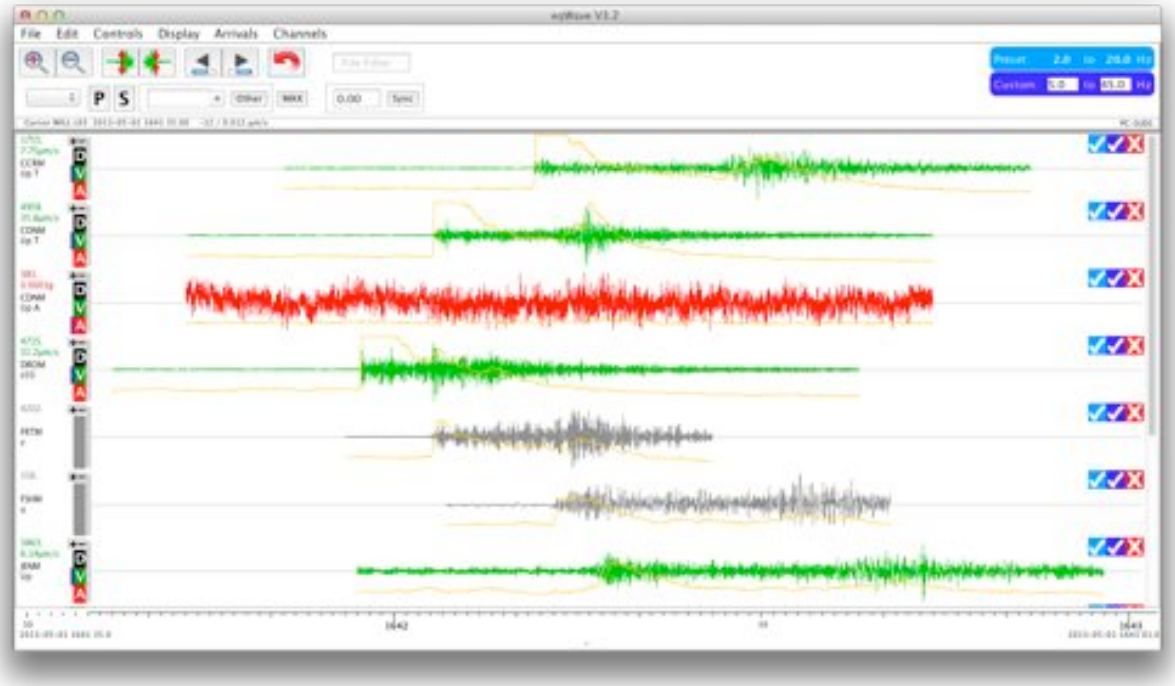
eqWave can merge up to 24 hours of data from many stations into a single file. Kelunji seismic recorders storing continuous data do so in one-minute data files, so it is possible that an earthquake recording will straddle two or more files. To make analysis easier you can merge these files together on screen and then save the merged file to your computer.

The quickest way to merge files is to have all of the files you want to merge in a single folder, and drag the folder into the eqWave window. All waveform files in this folder (and sub-folders) will be merged and displayed in a new eqWave window.




Alternatively drag a waveform file onto eqWave, and then use the **File->Merge** command, which will take you to the folder containing the file you just opened. In this file browser window, select all of the files you wish to merge using your multi-select file system shortcuts (usually Shift-, Control-, or Option-clicking) and proceed using the Open button.

As long as all of the files are within a 24-hour time period, they will be merged onto a common time line, grouped by site code in alphabetical order.



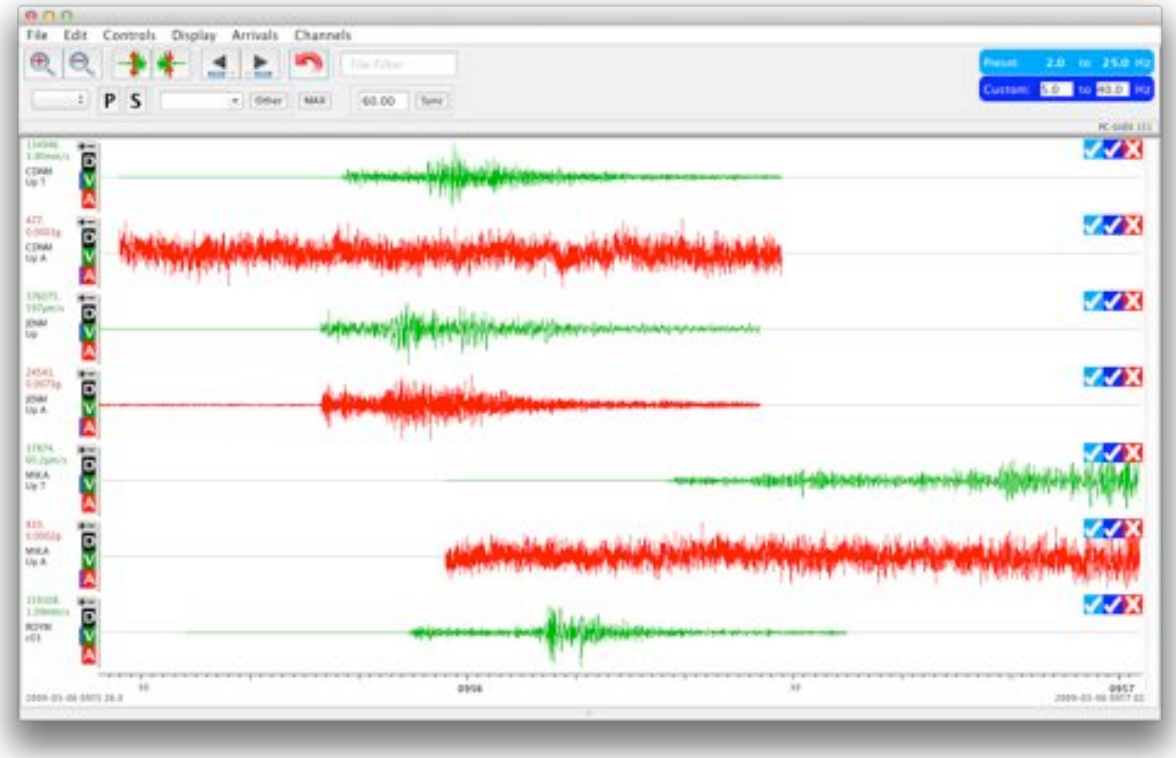
# Channels Menu

## Merged Files

When you are displaying a merged file, the site codes are listed in lower section of the channels menu. By selecting a site from this menu, you can view just this site in the eqWave window.

If you wish to return to viewing all sites, use the **Channels->All** menu command.

If you wish to view only the vertical channels to quickly pick arrivals from all of your sites, use the **Channels->Vertical** menu command. This will show all vertical channels for each site, typically channels 3, 6, 9 and/or 12.

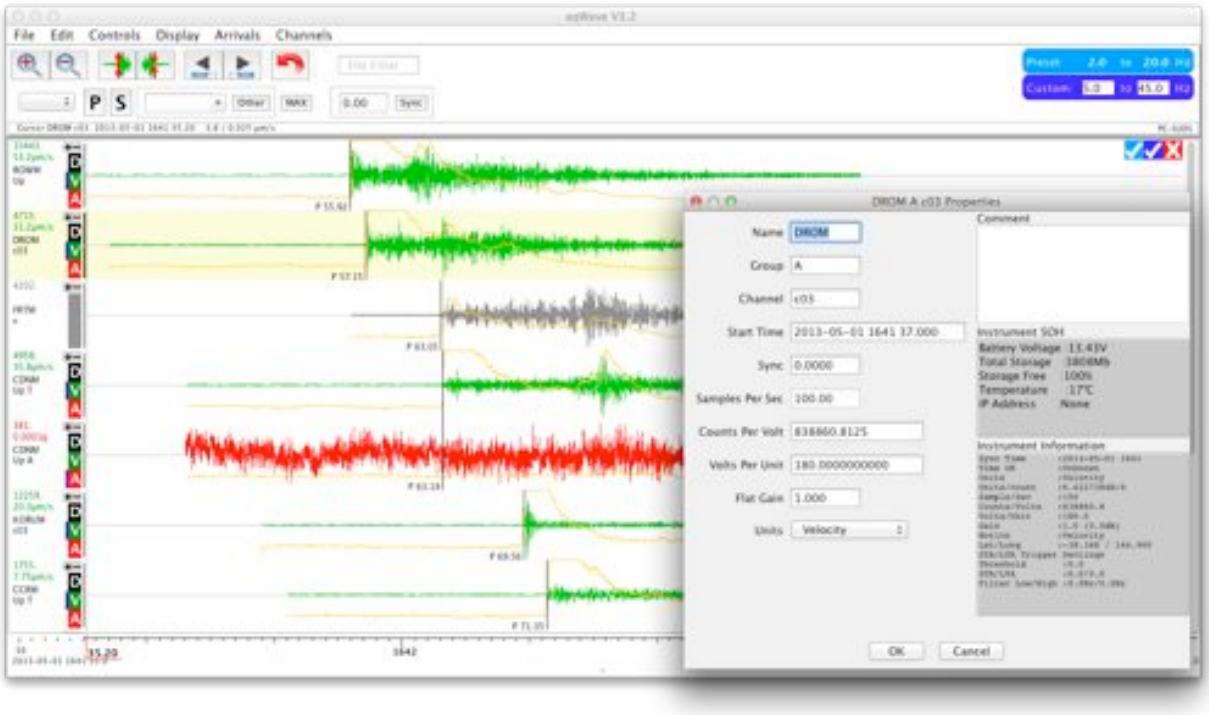



## Maximise and Minimise Channels

To view a channel full screen, use the small "+" icon at the top of the Y-axis bar for that channel, and then the "–" icon to go back. When all channels are shown, use the "–" icon to hide that channel from view. To restore any hidden channels, use the **Channels** menu to show **All** or **Vertical** channels, or the channels of a specific site.

# Channel Properties

Once you click on a channel it will be highlighted in yellow to show that channel-specific display items relate to this channel (e.g. the frequency spectrum display or channel information display). When you select **Channels->Properties** a window will pop up displaying extra information about this channel and the site.



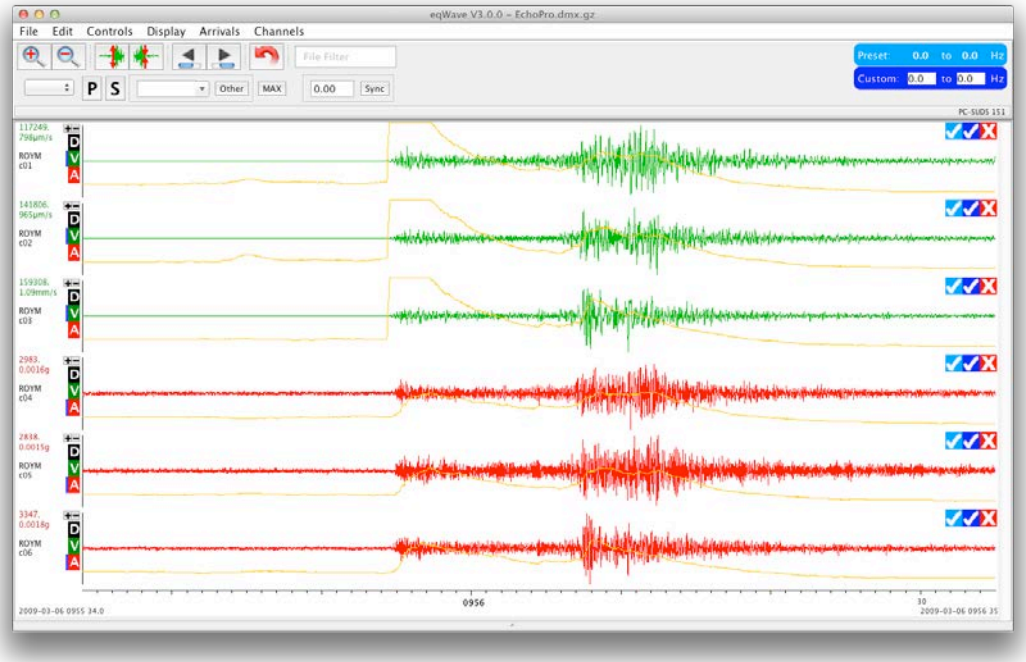

This information includes the system response information that is used to calculate the ground motion units from the raw data, some instrument state-of-health (SOH) information such as battery voltage, and site information such as the latitude and longitude of the site.

If you need to modify the system response (e.g. if you have a specific sensitivity for that sensor channel) you can modify the displayed fields and click OK to save these channel settings.

The editable fields have been populated by the Kelunji recorder, and changing these will change the raw data, so it is advisable to only fill them in if data is missing.

# Screen Elements

Once you have opened a waveform file, the data will be plotted in the main eqWave window showing the full time line of available data. The basic elements of the display will be described briefly below and expanded upon in later sections of the manual.




If a channel is recognised as having units in **velocity**, the trace will be drawn in green. If a channel is defined as **acceleration**, the trace will be drawn in red, and **displacement** in black. A key is shown at the left end of the waveform, marked as D, V, and A with a blue mark drawn next to the original units of the channel recording. Clicking on the D, V or A buttons will covert the waveform to these units. Other recognised units are **pressure** (magenta) and **rotation** (orange), and any unrecognised units are displayed in **dark grey**. The DVA boxes will disappear for these latter units as they cannot be transformed.

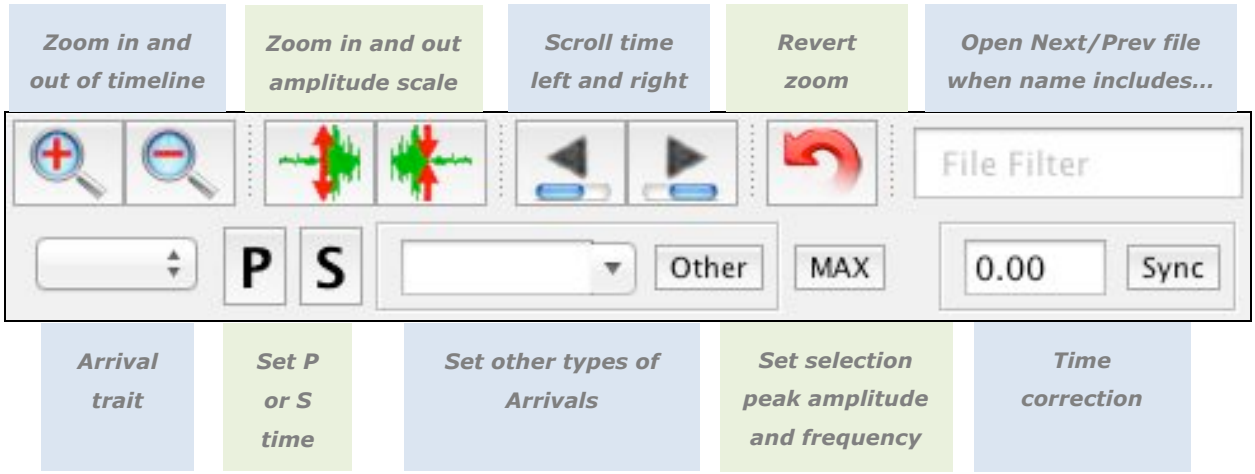
You will notice a yellow trace overlaid on your ground motion recording. This is the simulated STA/LTA ratio, which shows you how a recorder's STA/LTA trigger algorithm would see this data. The settings of this simulated STA/LTA ratio can be customised.

On the right-hand end of each channel are the filter control boxes. The ☑ icon will filter the waveform using the Preset filter settings. The ☑ icon will filter the waveform using the Custom filter settings which can be typed in at the top right of the screen. When a filter has been applied to a channel, the pass band appears next to the filter buttons. The X icon will clear the filter from the channel.

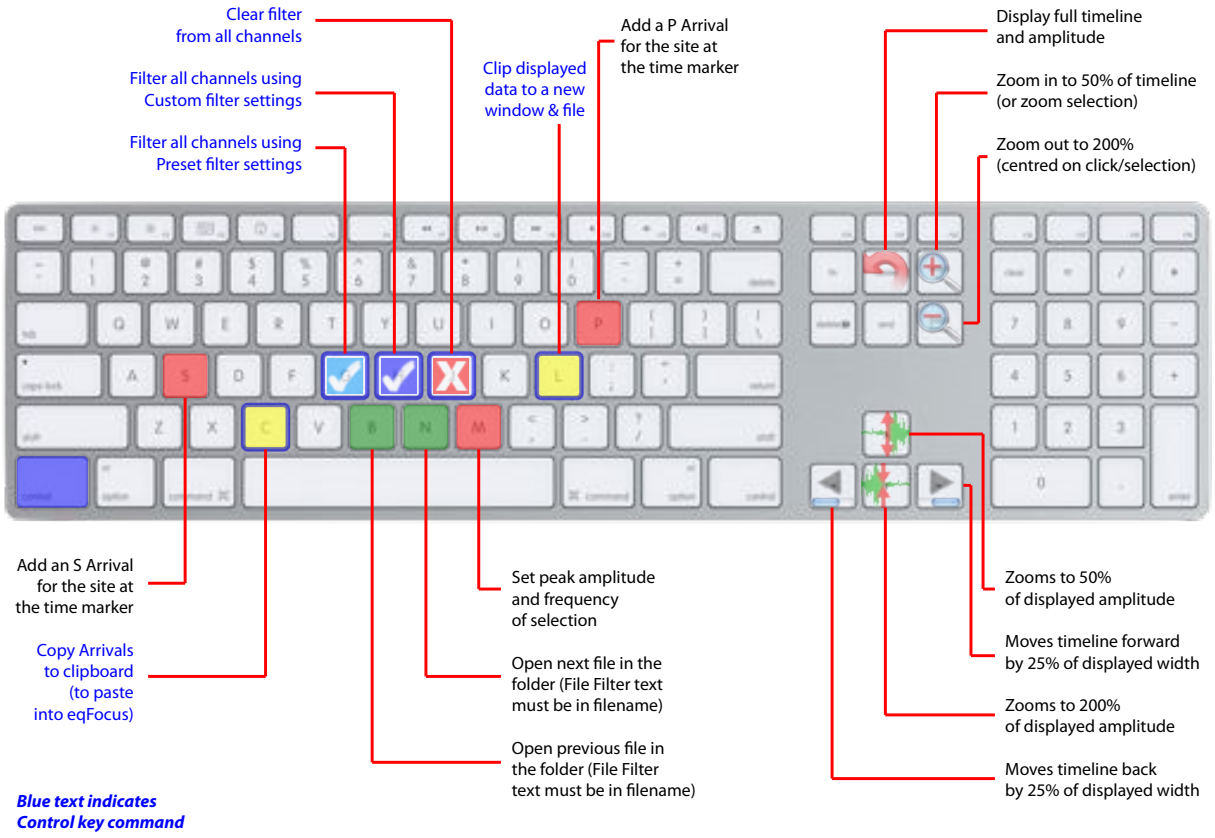
There is a bar at the bottom of the screen which can be dragged up to reveal the Fourier transform window, which shows the frequency spectrum of the current channel selection.

# Controls Menu

The control icons in the top left of the window are used to view the recordings in detail, to add arrival information to the waveforms, and to help process files.




Most of the buttons within eqWave have a corresponding keyboard shortcut, which are shown in the **Controls** menu. Commonly used shortcut keys are shown below.


Clear filter from all channels
Filter all channels using Custom filter settings
Filter all channels using Preset filter settings
Clip displayed data to a new window & file
Add a P Arrival for the site at the time marker
Display full timeline and amplitude
Zoom in to 50% of timeline (or zoom selection)
Zoom out to 200% (centred on click/selection)
Add an S Arrival for the site at the time marker
Copy Arrivals to clipboard (to paste into eqFocus)
Set peak amplitude and frequency of selection
Open next file in the folder (File Filter text must be in filename)
Open previous file in the folder (File Filter text must be in filename)
Zooms to 50% of displayed amplitude
Moves timeline forward by 25% of displayed width
Zooms to 200% of displayed amplitude
Moves timeline back by 25% of displayed width
Blue text indicates Control key command

# Zooming

All zoom commands are applied to all channels at the same time.

## *Point-zoom - Timeline*

Clicking and dragging your cursor over the waveform will show a red vertical marker bar. Move to the area you want to zoom into and release the cursor-click to leave a light grey marker line. Click the or use the Page-Up shortcut key to zoom in to the marker time by a factor of 2. Use the or use the Page-Down key to zoom out by a factor of 2, centred on the marker location.

## *Swipe-zoom - Timeline*

Instead of left-clicking and dragging a marker line, you can right-click and drag to highlight an area of interest. After releasing the click this area is left highlighted, if you place your cursor over the highlighted section and left-click (or use the zoom-in command) you will zoom in to the highlighted area. Using the zoom-out command on a highlighted area will zoom out by a factor of 2 centred on the selection area.

## *Amplitude*

By default eqWave will set the amplitude scale for each channel separately to the peak displayed. If you wish to manually scale the amplitude, you can do so using the and icons or the Up and Down arrow keys. Each tap of the icon or key will zoom the amplitude up or down by a factor of 2.

## *Revert*

To return to the original waveform display (reverting to the entire time line and the full amplitude scale) use the icon or the Home shortcut key.

# Scrolling the Timeline

The timeline can be scrolled horizontally using the and icons or the Left and Right arrow keys. With each tap of the icon or key the timeline will step back or forward by 25% of the displayed zoom level.

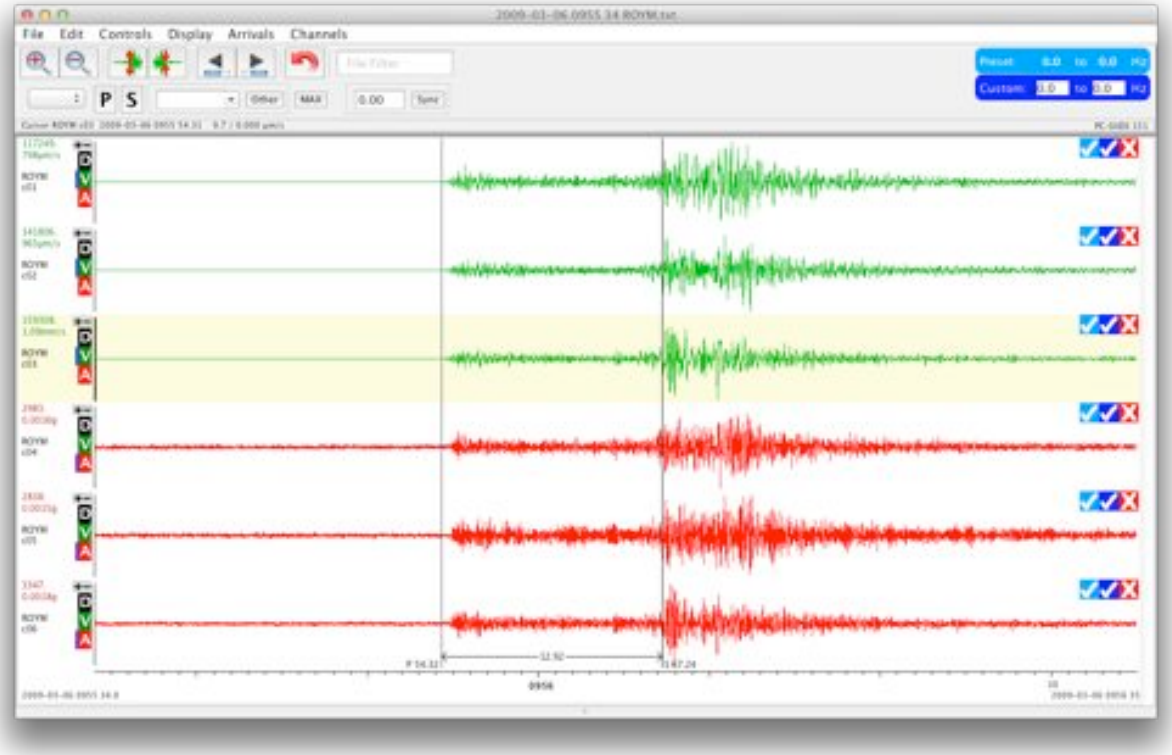
## Using the “Sync” feature

Older instruments did not use GPS and relied on internal clocks for timing. Clock errors can be compensated for by time-shifting data using the “sync” feature. Values from 0 to 30 seconds shift the data back in time, and a sync of 30 to 60 seconds will shift data forward.

# Picking Arrivals

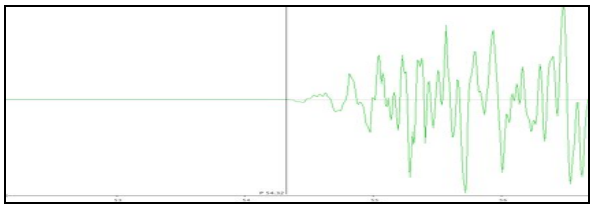
The main function of eqWave is to pick earthquake wave arrival times on the recordings to allow the determination of the location and magnitude of the earthquake using eqFocus. The intricacies of recognising and picking wave arrivals will not be discussed here, but we will cover the basics of picking P and S waves, and estimating magnitudes.

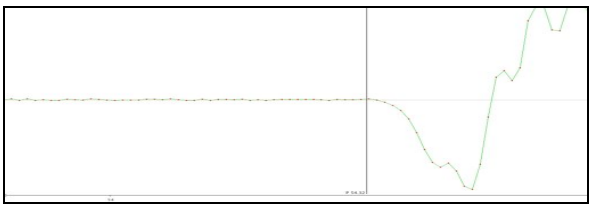
To mark an arrival time, click and drag the cursor to the point of interest and release, then click on the P icon or hit the “p” key. Similarly an S can be marked using the icon or “s” key.



# The P wave

The first earthquake energy wave to arrive at a seismograph is the P (or Primary) wave. As such they are generally easy to pick as there is usually a clear difference between the background noise and the earthquake arrival. The P wave is usually most obvious on the vertical channel of a sensor as it is pulsating in the direction of travel (up to the surface). As you can see from the screenshot above, the first vertical marker appears to be before the first arrival, but by zooming in we can see the P much more clearly.

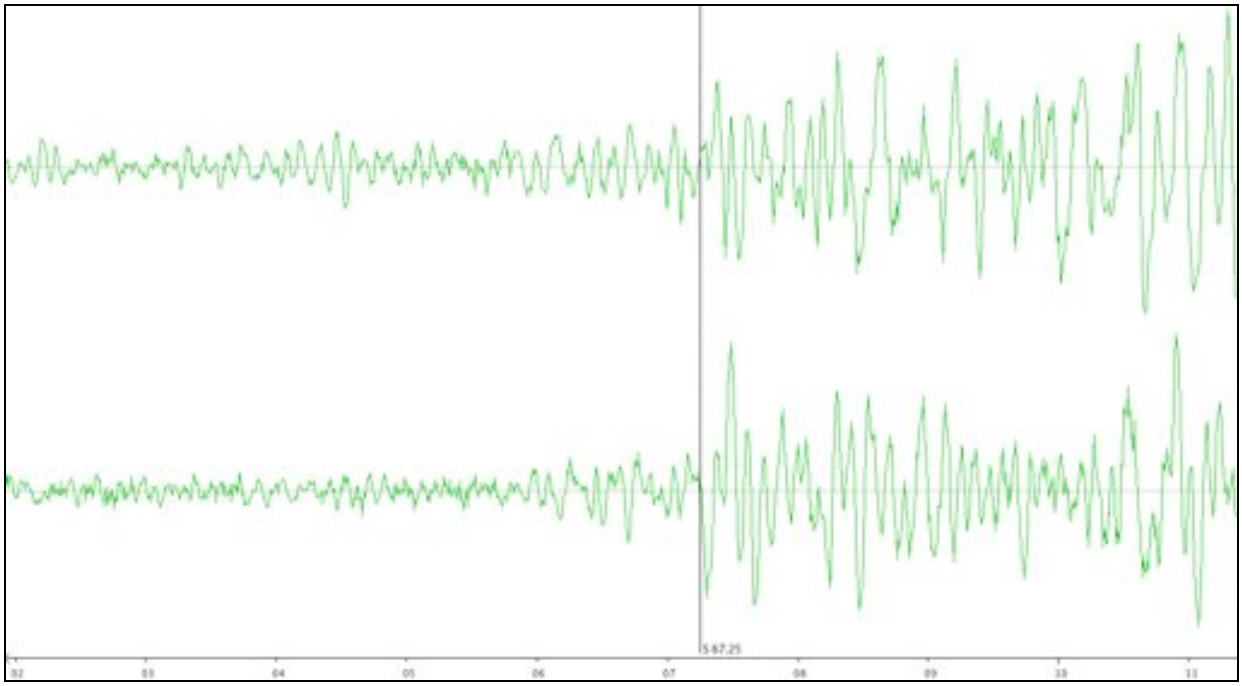


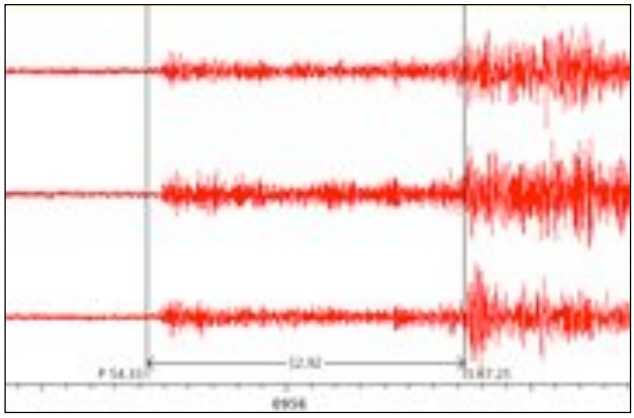


# The S wave

The next major earthquake energy wave to arrive at a seismograph is the S (or Secondary) wave. It is also known as the Shear wave as it is oscillating perpendicular to its direction of travel, i.e. it is shaking horizontally when it reaches the surface. This is the wave that often does the most damage during an earthquake due to this horizontal shaking and the larger amplitude. The S wave also usually has a lower frequency than the P wave.

Due to its motion, S waves are usually more obvious on horizontal channels, but as the S wave arrives in the coda of the P wave it is often difficult to determine a clear arrival time. Look for a point that correlates across the horizontal channels that features a drop in frequency and increase in amplitude.

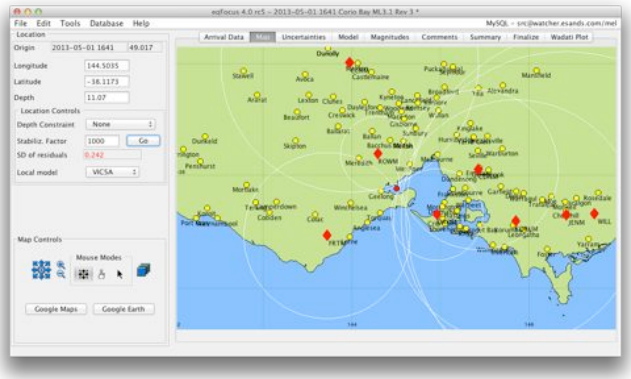




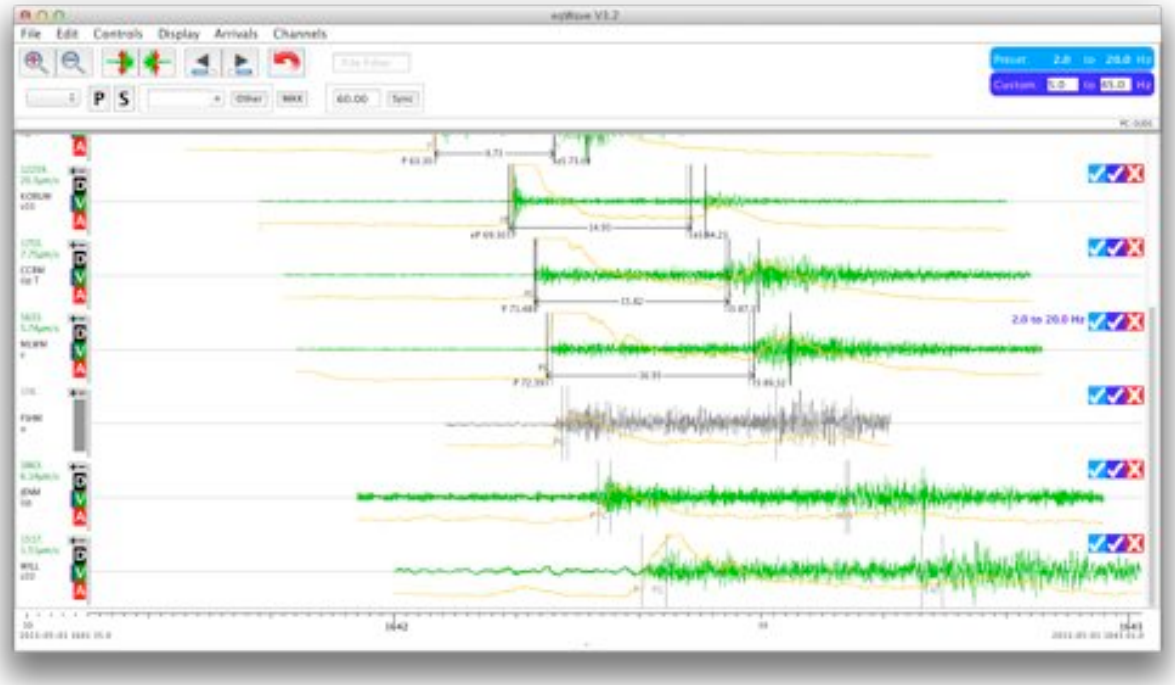
Once you have picked a P time and an S time, eqWave will display the "S minus P" (or S-P) time in seconds. The time difference between these arrivals equates to the distance that the earthquake is from this site. A rule of thumb to calculate the distance is to multiply the number of S-P seconds by 8 to estimate the distance in kilometres, e.g. 13 sec S-P = 104km.

# Expected arrival times

If you are using eqFocus (see right, sold separately) to locate seismic events, the expected P and S arrival times (and PG and SG arrival times, if appropriate) for the event are superimposed on the waveforms in eqWave as light grey lines.

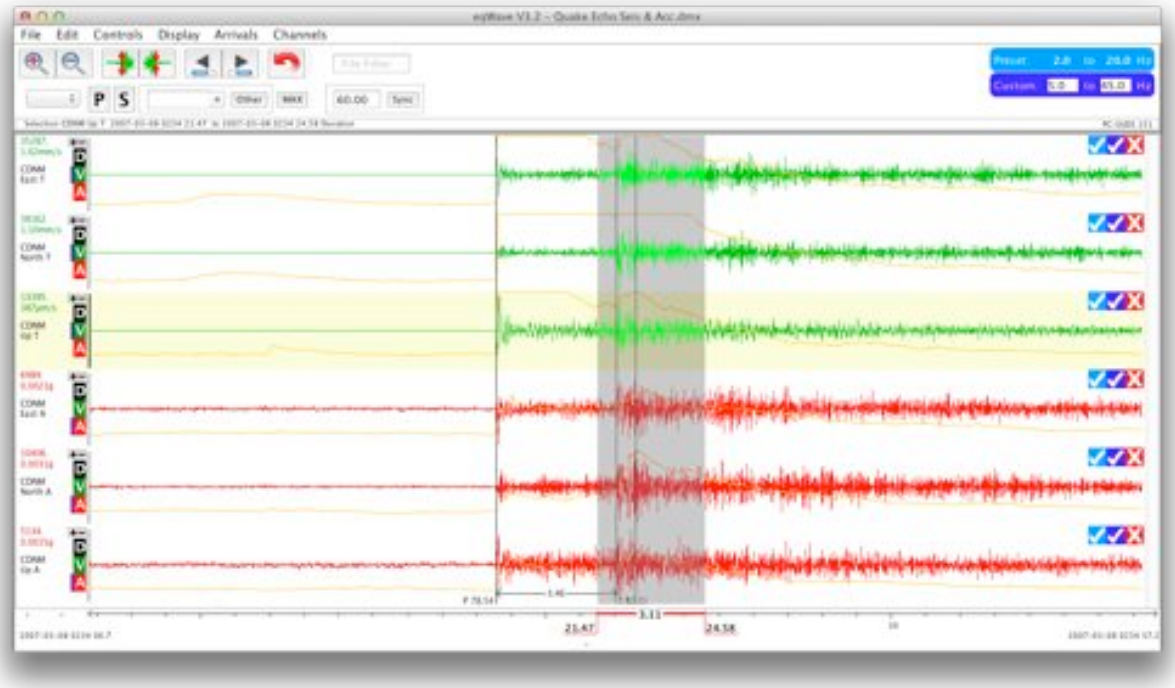


The expected arrival times are updated as eqFocus completes its calculations. This can help users to see arrival times hidden in codas and background noise.

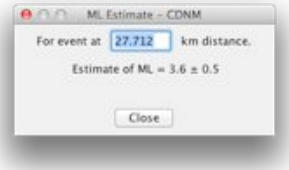


# Estimating Magnitude

Once you have a distance (automatically calculated by eqWave based on the S-P) you can estimate the magnitude of the event using the peak vertical velocity amplitude and the dominant frequency around this peak. On a vertical velocity channel (either natural velocity or transformed from acceleration) right-click and swipe the area of peak motion, which usually occurs after the S arrival for a few seconds. Click the **MAX** control button or type "m" and eqWave will assign an arrival storing the peak amplitude value and the dominant frequency in the selection.




*Note: when you highlight a section, the start, end and length of the selection are displayed on the timeline.*




Use the **Display->Estimate ML** menu item to pop up a window that will show the event distance and magnitude. This is a very rough estimate based on a number of assumptions and should not be considered a true representation of these earthquake parameters.

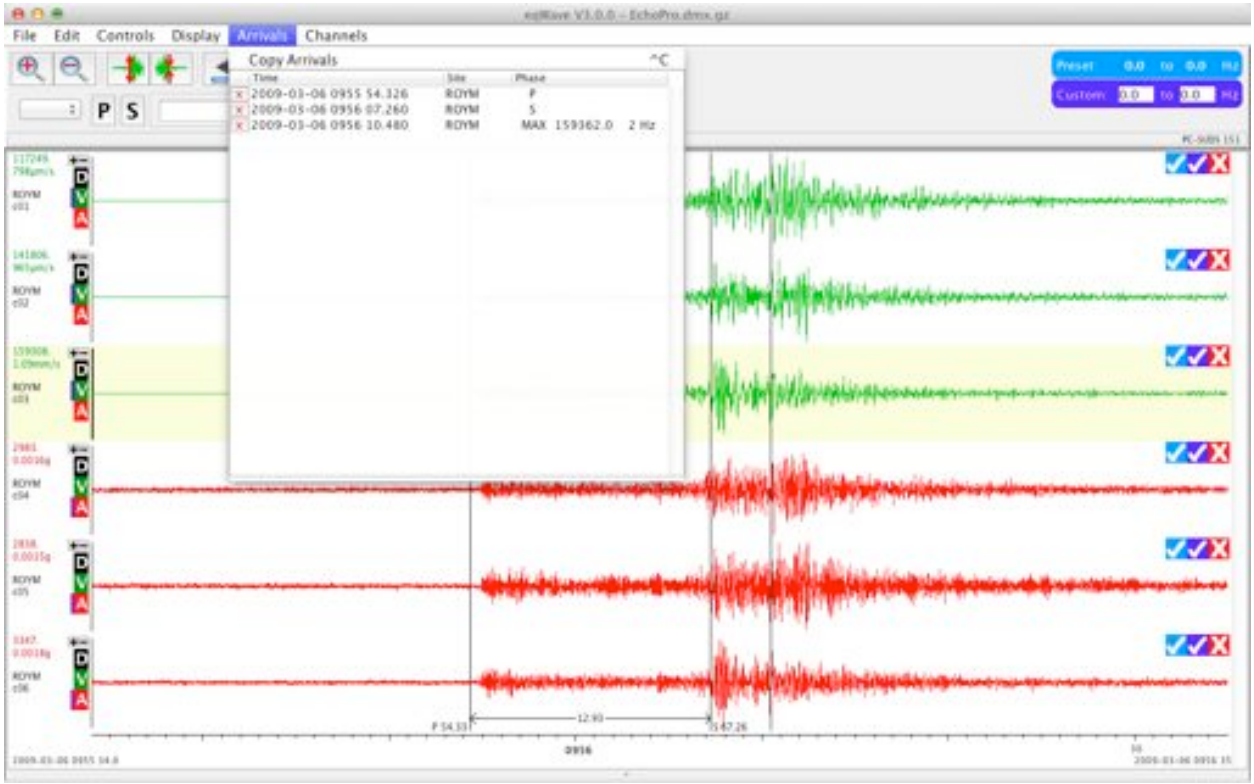
**Disclaimer:** eqWave uses hard-coded variables to calculate event distance which may or may not fit with P and S wave travel velocities for your region. Similarly, eqWave uses a generic magnitude calculation formula that very roughly estimates local Richter (ML) earthquake magnitude, which may or may not apply to ground motion attenuation factors in your region. For accurate location and magnitude calculation you will need three sites to have recorded the event, each with P, S and MAX arrivals picked. This data can be pasted into eqFocus, which should be used with a localised earth model.

# Other Arrivals

A drop-down list is available in the Basic Controls area that shows some other common arrival types, including PN, PG, SN and SG waves, and other magnitude amplitude arrival definitions. You can enter any custom arrival type you require in the drop-down text field and click **Other** to set the arrival at the current marker position.

# Arrivals Menu

Whenever you define an arrival, such as P time, S time, or MAX peak, this data is placed in the Arrivals menu. For each Phase (arrival type) the Time and Site code are shown, the latter required because eqWave can store arrivals from many sites in the same file.




If you wish to remove an Arrival from the list, click the red **X** next to the Arrival and its marker will disappear from the main window. Be aware that this action cannot be undone.

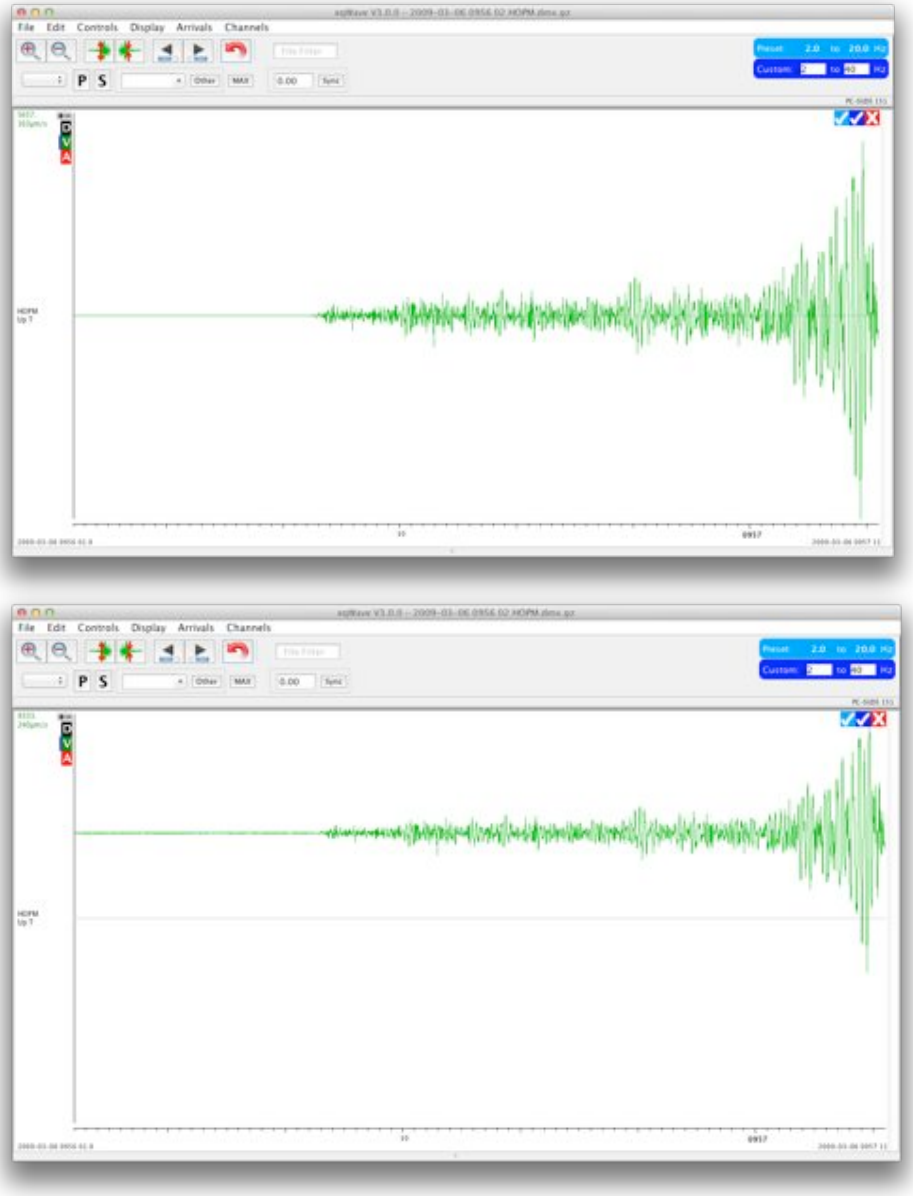
Use Control-C (or select the top item in the Arrivals menu) to copy the list of arrivals to the clipboard, which can be pasted into eqFocus (sold separately) for accurate earthquake location and magnitude determination.

# Display Menu

The Display menu is used to modify the way the waveform data or on-screen elements are displayed, and also contains the **Estimate ML** (magnitude) feature discussed in an earlier section of this manual. Version information about eqWave is in the **Display->About** item.

## *Zero Correction*

When a sensor is plugged into a recorder it will almost always have some level of signal offset, which can be due to the sensor not being perfectly level or the sensor components having some sort of electronic adjustment required. Regardless of the cause, the display of offset data can be handled by eqWave in various ways. The raw data is never modified, only the way it is displayed. Each channel is corrected individually.



An example of data with zero-offset correction (top) and without zero-offset correction (bottom) is shown at left.

The offset correction can be based on the zero-offset of the visible data (**Displayed**) or based on the zero-offset of the entire channel (**All**).

Please note that the amplitude shown at the Y-axis is the peak raw value, and without zero-offset correction enabled the motion units may lack relevance.

## *Amplitude Grouping*

To maximise the detail of the displayed data, eqWave will scale the amplitude of each channel to fill the vertical space allowed for each channel, which means each channel will have an **Individual** peak amplitude scale on the Y-axis. You can choose to group the amplitudes by **Site**, which will scale all channels with the same site code to the largest channel amplitude based on the raw data amplitude, not ground motion. Alternatively you can group **All** channels to the single largest amplitude in the file, regardless of site code.

The exception to the scaling rule is channels that have been converted from their natural units (usually velocity or acceleration) to other units – they will always scale individually.

## *Acceleration Units*

When displaying acceleration, eqWave can display amplitude in *g* (gravity) or in $m/s^2$ (metres per second squared). This user preference is stored in your user profile.

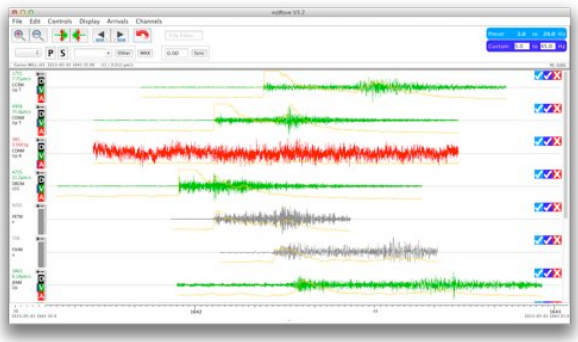
## *Pressure Units*

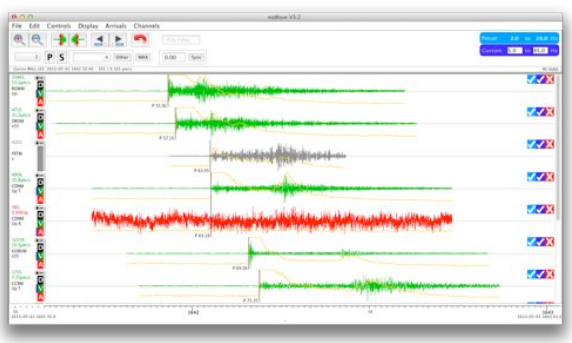
When displaying pressure (usually a recording from a microphone), eqWave can display amplitude in Pa (pascal) or as SPL (sound pressure level, measured in dB). This user preference is stored in your user profile.

## *Show and Sort*

As discussed earlier, when you pick a P time and an S time, eqWave displays the S-P time on screen. You can turn the **Show S minus P** feature on and off by selecting this item.

By default eqWave will **sort** the displayed channels **by Sitecode** in alphabetical order (image below, left). You can also choose to re-sort channels by **P arrival** time so that the closest sites to the earthquake appear at the top of the main window (image below, right). Sites that have no P time picked will appear below those that do, in alphabetical order. If eqFocus is active, sites with no P picked will be sorted using the expected P arrival time.



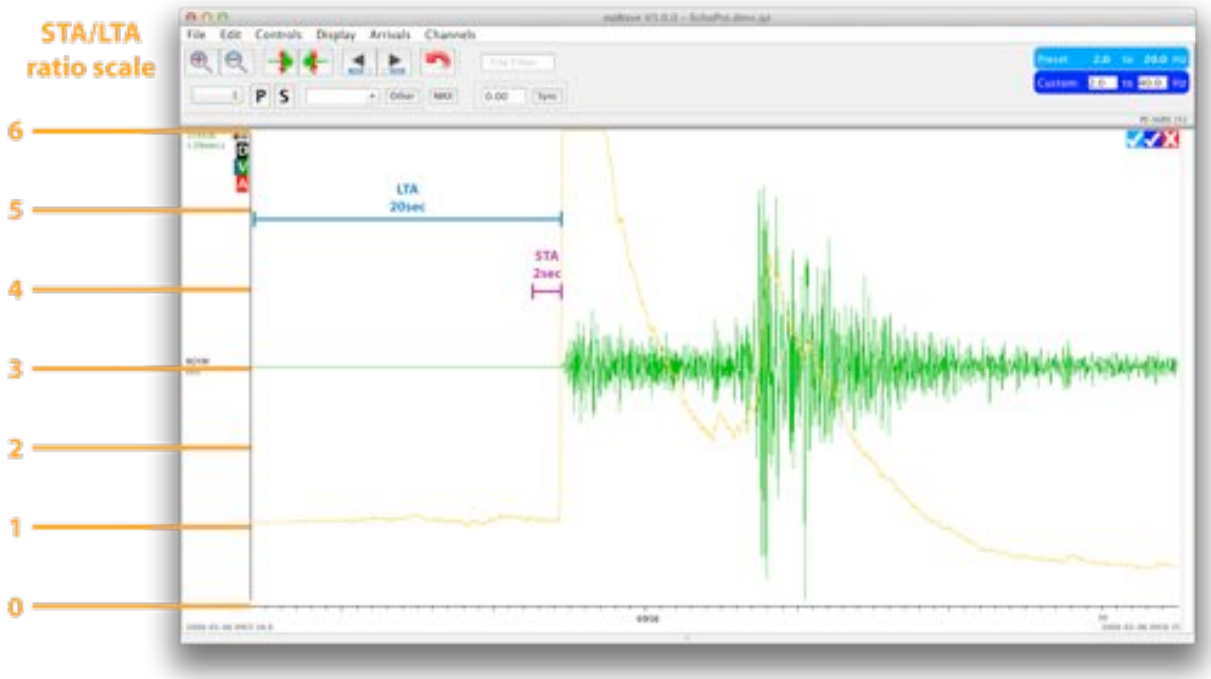


## *STA/LTA*

As mentioned earlier, the yellow line that appears on each channel is the STA/LTA ratio, which is how a recorder using STA/LTA triggering will see the data.

STA stands for **S**hort **T**erm **A**verage and LTA for **L**ong **T**erm **A**verage. This is the average signal level over a short time period (e.g. 2 seconds) compared to the average signal level over a longer time period (e.g. 20 seconds). The ratio of the STA level to LTA level is plotted in yellow on the screen. The scale of this plot is related to the trigger threshold ratio, which is a level at which you would expect the seismic recorder to declare than an event is underway. The trigger threshold is plotted at the zero-level of the channel, so the Y-axis range is a ratio of zero to twice the threshold level.

In the example below, the STA setting is 2.0, the LTA is 20.0, and the threshold is 3.0. As you can see, before the earthquake the STA and LTA values are similar and the ratio of the average signals sits at around 1, but as soon as the earthquake hits, the signal level in the STA window is many times larger than the average signal in the previous 20 seconds and the ratio shoots through the threshold. At this point the recorder would declare a "trigger" and store the data away.




This feature is used to help you to understand the sensitivity of your recorder's trigger settings. You can modify the STA, LTA, and threshold values in the **STA/LTA->Setup** menu item. You can also define the frequency band of the signal that the STA and LTA windows are averaging to better tune your recorder to trigger on certain event types.

You can turn the STA/LTA plot on and off toggling the **STA/LTA->Show** menu item.

# Edit Menu

## *Clip visible to new window*

You may wish to create a new seismogram file with a subset of the data in the currently-displayed eqWave data file. You may wish to remove channels or restrict the time period so that you are only left with data relevant to your analysis requirements. The **Clip** function (also accessible with the CTRL-L keyboard shortcut) will open a new window that contains only the data that is visible in the vertically scrolling main window in eqWave.

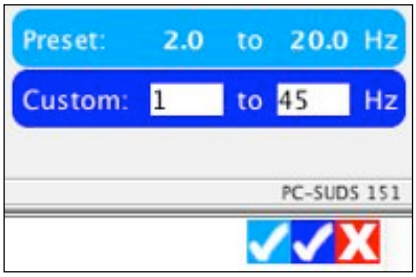
This means that any channels that have been hidden using the "minus" button at the top of the Y-axis will not be exported to the new file, and only the data from the current timeline zoom level will be exported to the new file. The data will appear in the new window in it's original units, but filter settings will be carried across, although they can be cleared so that the original raw data can be displayed.

## *Filter settings and controls*

The other menu items under the Edit menu relate to editing and applying frequency filtering to the waveform data. This is discussed in detail in the next section, Filtering.

# Filtering

Signal filtering in eqWave has been improved to be more user-friendly and more-easily controllable by channel. eqWave can perform a band-pass filter on the displayed data (to show data between two defined frequencies). It is important to note that the raw data is never modified – the data is only filtered for display purposes.




## *Preset and Custom filters*

A user will typically be interested in a particular frequency band, so eqWave allows the definition of a Preset band pass filter. To set the filter, go to **Edit->Preset filter settings…** which will bring up a window defining the High Pass and Low Pass filter frequencies. Signals with frequencies below the High Pass frequency will be removed, as will signal with frequencies above the Low Pass frequency. Once defined, these values are displayed in the light blue box in the top right corner of the eqWave control panel.

eqWave also allows the user to set a variable frequency band filter by typing values into the dark blue Custom filter box, located below the light blue box. Type the High Pass frequency (the lower value) into the left-hand box and the Low Pass (higher value) in the other box.

## *Setting and Clearing filters*

To apply a filter to a channel, simply click on the light blue or dark blue tick at the top-right corner of the channel display area, which will apply the Preset or Custom filter respectively. Once a filter has been applied to a channel, the pass band is written in text to the left of the light blue filter tick so that you are aware that the data displayed has been filtered.

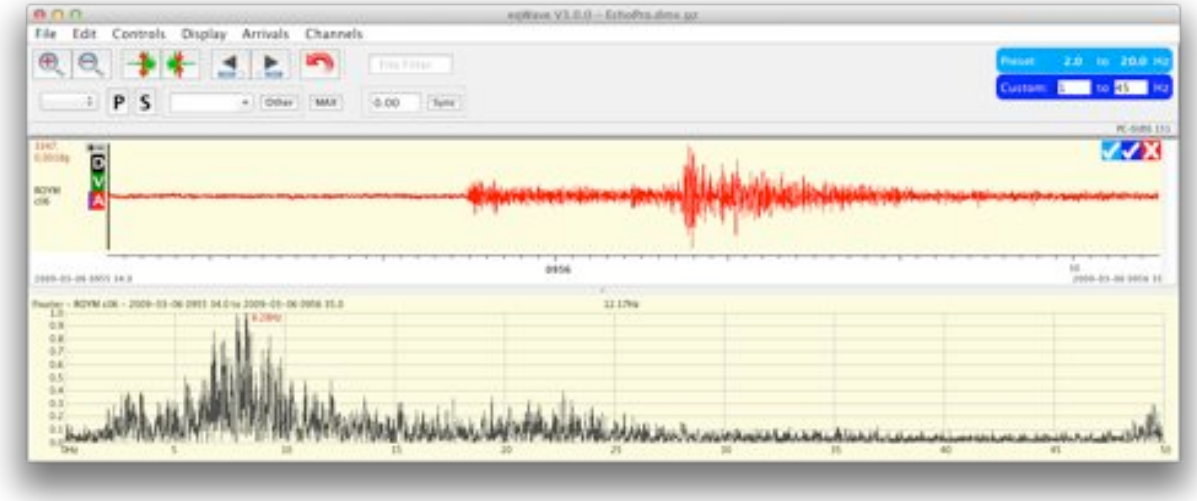
To clear the filter and return to the original channel data, click on the red cross.

To apply the Preset filter to all channels in the eqWave window, you can use the menu item **Edit->Apply Preset Filter to all channels** or the CTRL-G shortcut key. Similarly, to apply the Custom filter to all use the **Edit->Apply Custom Filter to all channels** menu item or the CTRL-H shortcut key. You can use **Edit->Clear Filters on all channels** menu item or CTRL-J to reset all channels to their original unfiltered state.

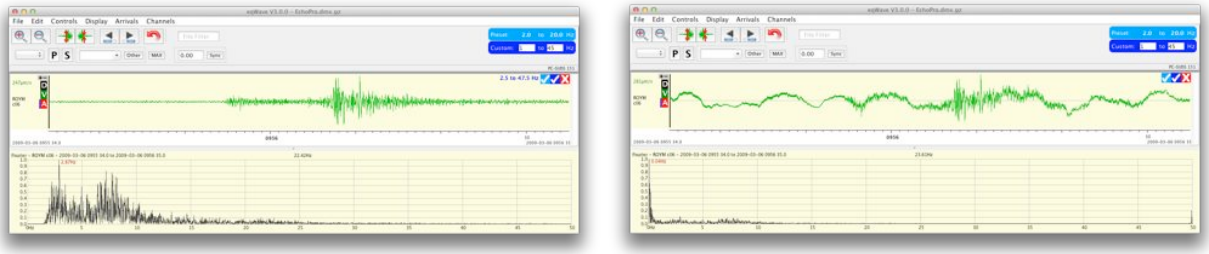
## *Automatic filters on unit-converted data*

You may notice that when you convert from Acceleration to Velocity or Displacement and when you convert from Velocity to Displacement that the unit-converted data has been filtered to drop 5% or 10% of the frequency band from either end of the spectrum. This is done to make the data appear more readable as the unit conversion process (in this direction) introduces very low frequency and very high frequency artefacts, which can be seen in the Fourier transform display, demonstrated in the images below.

You can change or clear these filters after conversion to suit your analysis requirements.



*Above: original unfiltered acceleration data and frequency spectrum*



*Above: acceleration converted to velocity, auto-filtered (left) and unfiltered (right)*

*Above: acceleration converted to displacement, auto-filtered (left) and unfiltered (right)*

# File Menu

The open, close and merging features of this menu have been discussed earlier. The remaining items in this menu are discussed below.

# Exporting Data

Once you have merged, clipped, or modified your seismogram file you can save it using the **File->Save** command or CTRL-S. This will overwrite the file whose name is displayed in the title bar or the eqWave window.

## *"Save As" file and name formatting*

If you do not wish to overwrite the file, you can use **File->Save As** or CTRL-T to save your data to a new file. In the Save dialog box that pops up there are control options for naming the file. The "SRC" filename format follows the form:

**YYYY-MM-DD hhmm ss SITE**

If you are saving a Merged file the SITE code in the file name will be one of the channels from the recording, depending on the order in which they were merged by the system. If you decide to use the "GA" filename format, the file will be named in the form:

**SITE**YY**DDD_hhmmss**

…where YY is the last two digits of the year (e.g. 13 for 2013) and DDD is the day number of the year (i.e. 001 to 366).

By default eqWave will save files in PC-SUDS 151 format (file extension .dmx). An alternate file export option is to save the file in a text-based format, whose columns are tab-delimited so that it can be viewed in a text table in a text editor or spread sheet. The formatting of this file is described in the following section. Click on the radio button next to the file format to select it either PC-SUDS or text file format.

Your **Save As** preferences are remembered by eqWave, so please check before saving.

## *Text Table file format*

When you save your seismogram as a text file it will be in a format that can be easily read by any text or data processing program. It contains a header that describes the Arrivals contained in the, a section that describes the time series data in the file, followed by the raw data.

Any arrival information contained in the seismogram will be listed in the first section. Each arrival will have its own column detailing the site name, arrival type and time.

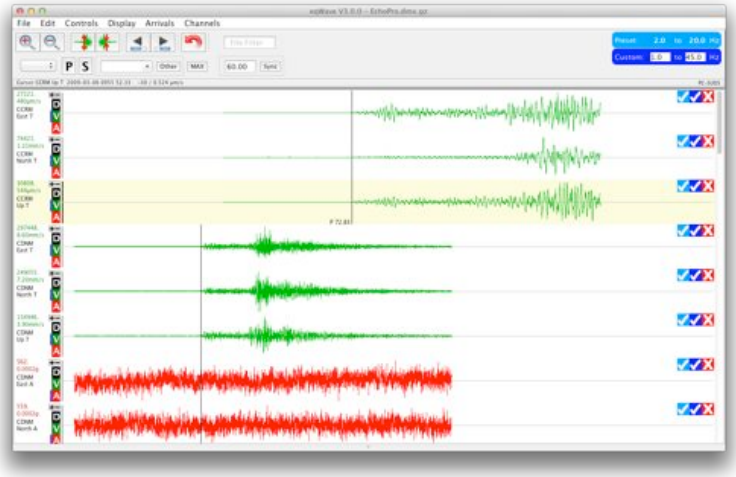
The next section describes the raw data, one channel per column. This includes the site name, channel name, the date and time of the first data point (or "sample"), and how many samples there are per second. As you may have merged data of differing sample rates, there may be a variable number of rows per column for a given time period.

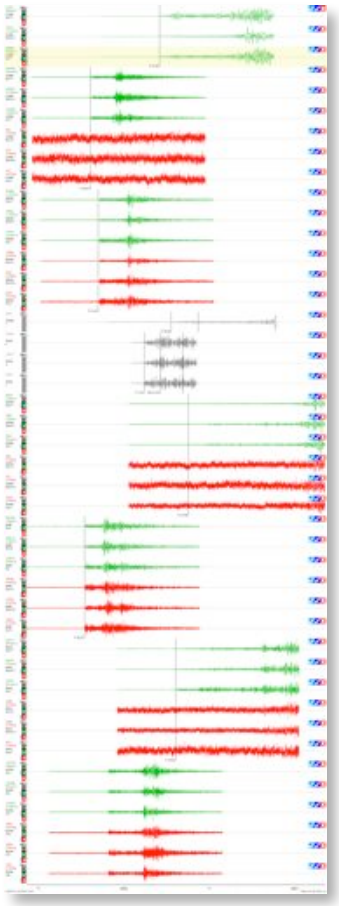
The final row before the data points indicates the units of the data, which could be metres (m), metres per second (m/s), metres per second squared (m/s/s), etc. The data is then displayed in these units, one sample per row. All data is saved with zero-offset correction.

```
ARRIVALS
ROYM        #sitename
            #onset
            #first motion
P           #phase
20090306    #year month day
0955        #hour minute
54.400      #second
0.100       #uncertainty in seconds
-----       #peak amplitude
-----       #frequency at P phase

TIME SERIES
ROYM        ROYM        ROYM        ROYM        ROYM        ROYM        #sitename
c01 A       c02 A       c03 A       c04 B       c05 B       c06 B       #component
unnamed     unnamed     unnamed     unnamed     unnamed     unnamed     #authority
20090306    20090306    20090306    20090306    20090306    20090306    #year month day
0955        0955        0955        0955        0955        0955        #hour minute
34.000      34.000      34.000      34.000      34.000      34.000      #second
100         100         100         100         100         100         #samples per second
6100        6100        6100        6100        6100        6100        #number of samples
0.000       0.000       0.000       0.000       0.000       0.000       #sync


m/s         m/s         m/s         m/s/s       m/s/s       m/s/s
--------    --------    --------    --------    --------    --------
-0.0000000  0.00000006  0.00000001  -0.0006574  -0.0007563  0.00000194
0.00000000  -0.0000000  0.00000005  -0.0002623  -0.0006263  0.00035027
-0.0000000  -0.0000000  0.00000006  0.00049667  -0.0002468  -0.0010950
-0.0000000  0.00000006  0.00000002  -0.0001947  0.00039259  -0.0002216
-0.0000000  -0.0000000  0.00000004  -0.0003767  0.00039779  -0.0002216
0.00000001  -0.0000000  -0.0000000  -0.0005482  -0.0003976  0.00016311
-0.0000001  -0.0000000  0.00000001  0.00014834  0.00029381  -0.0000500
-0.0000000  -0.0000000  -0.0000000  0.00001837  0.00016904  -0.0006219
-0.0000000  -0.0000000  0.00000003  0.00007556  0.00036140  -0.0001956
-0.0000000  -0.0000000  0.00000002  0.00019513  0.00011705  0.00012152
0.00000001  -0.0000000  0.00000002  0.00042388  -0.0004548  0.00029308
…etc
```

## *Save Screenshot*

Although most computers have a screenshot feature, eqWave allows you to save a PNG format image of just the data window, excluding the control panel and window frame. If you have many channels in the scrolling window, the screenshot will be very tall.





*Screenshot of a merged file from a laptop screen (above) and the same merged file saved as a screenshot in eqWave (right)*

## *Save Fourier*

You can also save the data displayed in the Fourier transform window to a text file. Simply right-click on a channel to display the frequency spectrum for the entire channel recording, or right-click and drag a portion of the data you wish to analyse and its frequency spectrum will appear in the Fourier window.

By selecting **File->Save Fourier** the data that is being displayed in the Fourier transform window will be output in three columns, the first showing the frequency point (in Hz) followed by the real and imaginary values of the spectrum (the amplitude).

# Print

If you would like to print your waveform you can use the **File->Print** or CTRL-P command. It will print effectively the same information as the eqWave screenshot, except that it will print up to 9 channels per page to the maximum scale to fill the page.

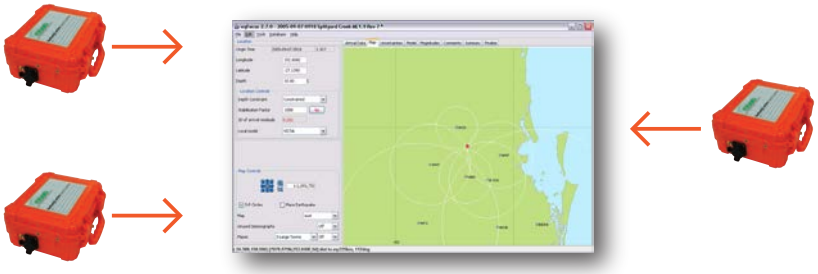
# Close and Quit

Close the eqWave window using **File->Close** or CTRL-W to return to an empty eqWave window. Use this command again or **File->Quit** or CTRL-Q at any time to quit eqWave.

# SOFTWARE TO COMPLEMENT YOUR ECHOPRO

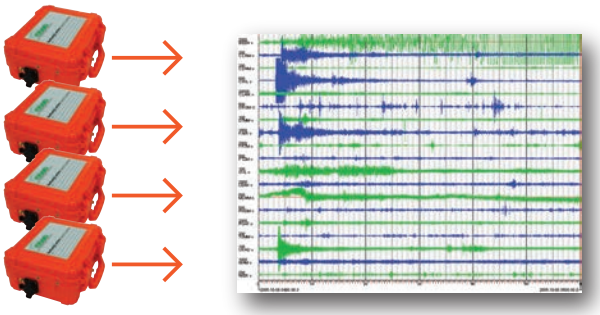
## eqFocus

Calculate earthquake location & magnitude from your EchoPro seismic network



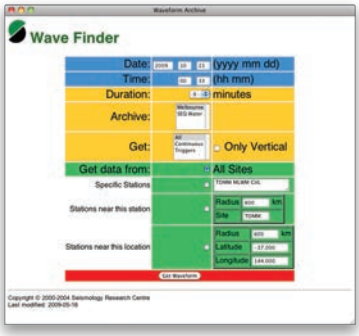
## eqLogger

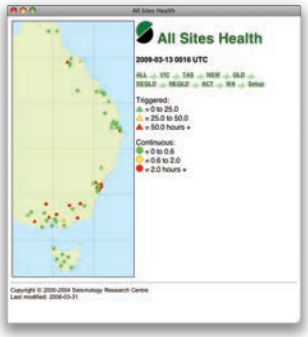
Display continuous data in real time and automatically store it in a data archive

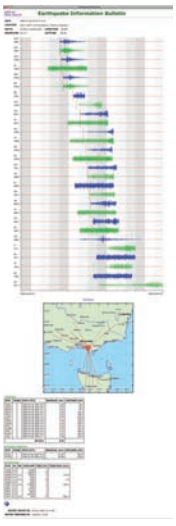


## eqServer

Data acquisition, archiving, alerting & network management



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